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Report of the Seminar and Study Tour for
African Specialists on Mining Methods

Krivoy Rog, USSR, 1-12 June 1981

LC/NAIROBI

FINAL REPORT

INTRODUCTION

1. The Seminar and Study Tour for African Specialists on Mining Methods was one of the projects of the United Nations Economic Commission for Africa's programme of work and priorities for the period 1980-1981.

2. The objective of the Seminar and Study Tour was inter alia, to improve the managerial and technical competence of African specialists on mining operations through lectures, excursions to operating mines, visits to well established supporting institutions, discussions etc., to be undertaken in a suitable region with a long history of mineral resources development.

3. Through the support of the Government of the Union of Soviet Socialist Republic (USSR) and the United Nations Regular Programme of Technical Assistance, the Seminar and Study Tour was organized by the United Nations Economic Commission for Africa (ECA) and was held in Krivoy-Rog in the Ukrainian Soviet Socialist Republic from 1 to 12 June 1981.

4. The host country institution directly responsible for the organization of the Seminar and Study Tour in collaboration with ECA was The Mining Scientific Research Institute of Krivoy-Rog (MIGRI)

5. Twenty-eight African specialists from 26 countries and one international institution, two external consultants, staff members of the United Nations Department for Technical Co-operation for Development, the Economic Commission for Africa (ECA) as well as over 35 experts from the host country participated in the Seminar and Study Tour.

OPENING OF THE SEMINAR

6. The Seminar was opened by Mr. G. Gutovsky, the Mayor of Krivoy-Rog on 2 June 1981.

7. He welcomed Seminar participants to the Ukrainian Soviet Socialist Republic and in particular to the Krivoy-Rog basin which was one of the country's most important metalliferous ore producers and had had a long history of mineral resources development.

8. He informed the participants about the evolution of the mining industry in Krivoy-Rog and the resultant growth and development of the city. The Krivoy-Rog basin offered the ideal environment for developing countries to see how mineral reources could be developed to serve the needs of a nation.

9. It was international duty of the Soviet people to utilise a portion of their resources to assist developing countries in building and strengthening their economies. Accordingly the USSR was already providing assistance to a number of African countries. He hoped that the results of the Seminar and Study Tour would strengthen co-operation between the USSR and Africa for the benefit and prosperity of their peoples.

10. He concluded by expressing his country's pleasure and readiness to render African countries scientific and technical assistance in their mining industries. He wished the Seminar and Study Tour every success.

11. On behalf of the Executive Secretary of ECA, a representative of the secretariat welcomed participants and conveyed the appreciation of the ECA secretariat to the Government of the Union of Soviet Socialist Republic (USSR) for its contribution to the project.

12. He stressed that the main objective of the Seminar and Study Tour was to offer the African specialists an opportunity to observe how the mineral resources endowment of a region could be used to promote self-reliant and self-sustaining socio-economic development within the same region so that the African experts could adopt some of the methods applied in African countries.

13. Furthermore, African specialists would wish to familiarize themselves with mining techniques and equipment for both small-scale and large-scale operations, observe the operation of support institutions for the mineral industries and develop fruitful contacts between themselves and others outside Africa so as to enable Africa to build up the capacity to exercise full sovereignty over its mineral resources.

14. Mr. S. Lissitsin, State Committee of the Soviet Union Council of Ministers for External Economic Relations, welcomed Seminar participants and expressed the hope that the preparations made by the Governments of the Ukrainian Soviet Socialist Republic and of the Soviet Union for the Seminar and Study Tour would ensure the success of the implementation of the project.

15. The USSR Government regarded the rapid economic development of the developing countries as one of the major requirements of the present time and the Soviet Union would continue to contribute towards the achievement of that objective in a manner acceptable to African countries.

16. On behalf of the Soviet institutions which were involved in the organization of the Seminar and Study Tour, Mr. A.R. Chernenko, Director of NIGRI Institute welcomed participants to Krivoy-Rog whose achievements in mineral resources development were a pride to the people of the USSR in general and the Ukrainian Republic in particular. He stressed the importance of mineral resources in industrial development and wished African countries success in their efforts to develop their mineral resources.

17. Mrs. L.P. Gribanova, the USSR Co-Director of the Seminar and Study Tour, welcomed participants to the NIGRI Institute and introduced them to the Mayor of the city. She outlined the programme of work for the Seminar and Study Tour and stated that the organizers of the project would do everything possible to ensure the success of the event.

18. On behalf of all the African Specialists participating in the Seminar and Study Tour, Mr. Mohamadou Issoufou of the Niger moved a vote of thanks to the Mayor of Krivoy-Rog city and all the USSR officials who took part in the organization of the project. He commended the mining tradition of the city and the efforts of the USSR Government to transfer mining technology from their country to African countries.

ACCOUNT OF PROCEEDINGS

19. The presentation of papers and the subsequent discussions were held at NIGRI, the institute in Krivoy-Rog which serviced the mining industry in the region. A total of 35 papers were presented by Soviet participants and these were interspersed by five papers from foreign participants. The sessions were conducted under the combined chairmanship of Mrs. L.P. Gribanova (USSR) and the representative of the ECA secretariat although several foreign participants were invited to chair some of the sessions.

20. In between the theoretical working sessions at NIGRI field visits to operating mines, Processing Plants and other relevant institutions in the Krivoy-Rog region were undertaken. The visits were of great interest to participants and generaled extensive discussion and exchange of views.

21. A brief description of the papers presented by the USSR and foreign participants is given below.

"Mineral resources of the Ukrainian" (Mr. V.I. Poturaev)

22. The speaker first described the important position that the Ukraine held in the total mineral wealth of the USSR. Manganese, iron and coal were predominantal though other more exotic minerals were either being exploited o known to exist.

23. Manganese occured as oxides and was worked mainly by open-pit methods although there were some underground operations too. Iron ore was principal centred in the Krivoy-Rog region and was mined by both open-pit and undergrou methods. Coal mining was carried out in the Donetz Basin by underground meth the average depth of the mines being 600 metres.

24. He then went into more detail concerning the technology being applied in those areas and highlighted the problems likely to be confronted as the workings reached lower depths. The paper formed a general introduction to th mineral resources of the Ukraine and provided good background material for th participants.

"Mining of iron and manganese ore deposits" (Messrs. A.P Chernenko, E.D. Prilipenko and V.A. Salganik)

25. The paper was presented by Mr. Prilipenko who said that the USSR was the biggest producer of manganese and iron in the world. Iron ore was being worked by both open-pit and underground methods and, at the present time, abo 75 per cent of the total production was from open-pits. Krivoy-Rog region wa one of the main centres for both iron and manganese mining and large complexe had been established for mining and treating the ores.

26. Open-pit mining of iron ore was being conducted at depths of up to 275 metres below the surface using conventional benching with railway, truck or conveyor, or combinations thereof, to transport the ore out of the pit, Problems associated with deepening the pits to 500 metres were receiving clos attention.

27. Underground mining at depths up to 700 metres were, in general, utilizing caving methods with the ore being transported by electric locomatives to the shafts and then skip hoisted to surface.

28. The mining of manganese was mainly by open-pit as seen in the mine visited by the participants during the Seminar.

29. Various questions were raised by participants, including the parametres used for sub-level caving, rates of dilution and recovery and the geological conditions under which the iron and manganese ores had been formed.

"Coal mining in complicated geological conditions" (Mr. V.N. Poturayev)

30. The paper dealt mainly with the conditions in the Donest basin. In particular the speaker considered problems that were likely to arise in the future as the mines became deeper. They were increases in rocks pressure, seams less than 1 metre thick, fluctuations in the thickness of seams, increases in ambient temperatures and greater quantities of gas emission. A description was given of the research work being conducted in those areas. The policy was to introduce more mechanization and automation with the possibility of adopting unmanned faces.

31. Several questions were asked about mechanization and also about the safety procedures to be adopted in highly mechanized mines.

"The Experience and prospects for employment of shaft and pneumatic supports" (Messrs. K.I. Onischenk and O.V. Kolokolov)

32. The speaker gave a description of a new form of support which was suitable for use in coal seams as well as in steeply dipping vein-type deposits. Basically, it consisted of a strong plastic envelops which could be wedged between the hanging and footwalls by being blown up with compressed air and then recovered again when no longer required by evacuating the air. It had considerable advantages over the use of timber, the principal ones being its ease of transportation and installation and the fact that it could be used several times over. Care, however, had to be exercised during installation to ensure that projecting rocks did not puncture or split the envelope.

"Mining of manganese bedded deposits" (Mr. V.P. Urbantsev)

33. The paper dealt mostly with the manganese mines in the Nikopol basin of the Ukraine where the deposits were being mined by underground and open-pit methods. Annual production from the region amounted to 6.5 million tonnes. The deposits contained both oxide and carbonate ores and graded between 17 per cent and 24 per cent Mn.

34. Underground mining was highly mechanized and the intention was to increase mechanization to increase productivity. The ore was soft and investigations were being made into introducing a shield type machine for development headings.

35. In open-pitting, the overburden was removed using large draglines and the ore excavated without blasting. A special feature of that method was the reclamation and rehabilitation of the soil to allow the mined-out areas to be recultivated.

36. The speaker closed by giving a brief description of the beneficiation processes which included gravity separation, magnetic separation and flotation.

"Technology of Underground Iron Ore Mining" (Messrs. I.P. Kononov, S.D. Myachin, A.P. Grigoryev, V.K. Shendrik and V.P. Voloschenko)

37. The speaker introduced the paper by saying that the share of underground mining in the Krivoy-Rog region in the future would increase and that depths of 1100 meters would be reached in the coming decades. Mines were being deepened at a rate of 20-25 metres per year.

38. The first method to be dealt with was sub-level caving which was the predominant one used where the ore body was weak and, with the inducement of limited drilling and blasting, would fragment the ore into material which could be easily handled in ore passes and haulage levels.

39. In other areas, where the rock conditions were stronger, sub-level open stoping methods could be utilized with post filling of the imined-out areas.

40. He drew attention to the kind of mining conditions that might be encountered at deeper levels and indicated that the research work being conducted by NIGRI suggested that the planning of future stopes would involve even closer attention to the aspects of mechanization, ground support control and temperatures.

"New technology and mechanization of work when mining" (Messrs. C.C. Kunetz and V.S. Gorbatov)

41. With regard to mine development, the speaker reported that approximately 220,000 metres of horizontal and 160,000 metres of raising work were performed in the Krivoy-Rog region annually.

42. Development headings on the horizontal were carried out at cross-sections of 10 to 12 m2 and various types of rounds were employed, dependent on the specific rock conditions. There was a trend to greater mechanization of the operations and the use of drilling rigs, rocker - shovels and self-propelled haulage cars was becoming more common.

43. At the moment, investigations were being carried out to increase considerably the length of each round to be blasted, in both main development ends and shafts. Average rates of advance were 50 to 60 metres per month although in specially equipped headings, rates of advance had considerably exceeded those figures. Raising had been improved by the application of self-propelled platforms from which drilling activities were performed.

44. In stoping, research was being directed to increasing the amount of mineral caved without increasing the explosives consumption.

45. One participant asked what the cost of development was and was told that it amounted to 40 to 50 roubles per m3.

"Scientific theories of creating methods for controlling the blasting energy while working the deposits by open-pit methods" (Mr. E.J. Efremov)

46. The paper covered the methods being applied in bench blasting of open-pits and the theory on which it was based. It gave rise to a great deal of discussion and was obviously relevant to the conditions met in some developing African countries.

"Problem on conveyerization at the mining enterprises" (Mr. E.E. Novikov)

47. With the deepening of pits and the difficulties being experienced in the use of rail and truck transport, considerable research was being conducted into the use of conveyor systems for transporting the ore directly from the open-pit to surface. Such systems were of high capacity and therefore deserved detailed consideration.

48. The major problems concerned the reliability of long distance conveyor systems, the size range of the material to be transported, the design of overloading devices, the gradients at which they could be operated and the systems of maintenance to ensure high availability.

49. Several questions were raised by participants amongst which were the economic depth at which conveyors could be used, the major cost item in conveyor installation and the position of the dirve drum in such systems.

"Methods of instrument control of the determination of conditions of mine shaft equipment" (Messrs. A.E. Gavrutsky, G.N. Mushinksy and F.L. Morenkov)

50. The speaker said that many of the underground mines in the USSR and the Krivoy-Rog region in particular were becoming deeper and, at the same time, were being expanded to increase production. That had meant the introduction of higher-capacity skip hoisting facilities and greater hoisting speeds as well as a reduction in the time available for shaft inspections. It was therefore necessary to develop equipment which would accelerate the latter procedure.

51. A device fitted to the shaft conveyance which was capable of measuring the clearnces between a conveyance travelling in the shaft and the shaft furnishings was described. Whilst it was possible to obtain a plotted chart showing the clearances to an accuracy of 1 to 2 mm. The time to carry out the inspection was normally less than 1.5 hours although, naturally, it depended on the length of shaf

52. Various questions were raised regarding hoisting practices in general as well as the reliability of the device described.

"Development of progressive technology and mechanization aids for mining in hard rocks and for ore picking" (Mr. S.A. Plyuansky)

53. With the plans that the USSR had for increasing production in the mining industry, there was an urgent need to develop faster and more efficient methods and equipment for development and stoping. In the paper, the author concentrated on how the USSR was tackling the problems of increasing the rate of advance of development faces and improving the cost effectiveness of the operation while, at the same time, preserving safe and environmentally acceptable working conditions.

54. In the main, the aims were achieved by mechanizing the drilling, blasting and cleaning cycles and he described the various types of Soviet equipment which had been developed for those purposes. Thus far, the results of mechanisation had considerably improved development efficiencies and further design and test work was underway to introduce even more efficient equipment.

55. The questions arising from the paper concerned the application of such equipment in very hard rock conditions, the air pressures that were required and the policy of the USSR in developing electric and electro-hydraulic equipment as opposed to compressed air.

"Calculation technique of parameters of structural elements of mining systems and equipment for the determination of their limiting state" (Messrs. P.A. Bogdanov, V.V. Tsarikovsky, V.V. Sakovich and A.V. Nedzvetsky)

56. With the deepening of many mines in the Krivoy-Rog region, as well as in the rest of the USSR, great attention was being paid to the design of mine development openings and to the planning and production scheduling of stopes so as to minimize the effects of increasing rock pressures.

57. For a number of years, the Research and Scientific Institute of the Mining Industry (NIGRI) had been developing theoretical and experimental methods of forecasting the behaviour of rock conditions and had now reached the stage of being able to calculate the optimum dimensions of complete mining systems and individual development headings, stopes and pillars. Such work had also contributed to a better knowledge of the processes of controlled caving, the sequence of mining individual stopes and the speed at which they should be mined. Formulae and tables were presented by which the necessary computations could be made.

58. The speaker also described the in-situ geotechnical equipment which was being used to monitor rock conditions, particularly those adjacent to active working areas.

59. The paper gave rise to a great deal of discussion which centred largely on the application of the method to other mines outside the USSR.

"Variation and differentiation method and its application in studying stress and strain conditions of the rock around mine workings."
(Mr. G.M. Shevtsova)

60. The paper dealt with the stresses and strains which developed around mine workings but concentrated in particular on those which developed as a result of mining separate hanging and footwall stopes leaving a waste pillar between.

61. The advent of computer technology now enabled reliable predictions to be made of the stresses involved using the variation and differentiation method. Parameters which were taken into account were the heterogeneity, lithology and structure of the rock and, as a result of the research conducted, it had been discovered that the most influential factors on stress/strain generation were the shapes of the stopes and the strengths of the intervening pillars.

62. The questions which followed concerned further clarification on how the mining of hanging-and footwall ore bodies should be carried out and the equipment which was employed to monitor the rock conditions.

"Supporting of deep underground mines" (Mr. I.S. Zitser)

63. The author stated that, with increasing rock pressures in the underground mines of the Krivoy-Rog region, there had been a need to design development heading support systems which would maintain accesses to the workings for the time they were required and, at the same time, be cost effective.

64. Amongst the systems described were yielding arches, roofbolting, with wire mesh, guniting and special sets used at the junctions of development headings. All were designed and selected taking due account of the special conditions at any mine, rock characteristics and the type of deposit being mined. In view of the high cost of timber, its use was being phased out and, in the case of yielding arches, lagging with split round poles was being replaced by perforated steel sheet.

65. Finally, he described a portable jack which had been designed and was used to instal yielding arches with the minimum of labours.

"Methods of determination, valuation and planning of ore mining at krivbass mines" (Mr. B.K. Plekhanov)

66. The author described the procedures which were employed to optimize a mining system in the Krivbass from the economic point of view. NIGRI had developed computer programmes which, given certain production indices and the characteristics of a mining block, would enable precise planning to be undertaken on the production of a balanced feed to the beneficiation plant at an optimized cost. The results of the work were being used in short, medium and long-term planning and formed the basis by which actual production was monitored.

67. Clarification on a number of points in the paper was given by the author.

"Problems of excavating deep iron ore mines" (Messrs. F.K. Alexeiv, V.G. Khrapach, N.I. Pavlikov, N.V. Khilchenko and B.E. Yaschenko)

68. The open-pit iron ore mines in the Krivoy-Rog region were mostly at depths of 250 to 275 metres but were planned to reach depths of 400 to 500 metres before underground mining would start. The main problem posed by this decision concerned the efficient and economic transportation of both ore and overburden. At presently transportation was by rail and, because of its relatively low operating cost, the intention was to continue with this type of system to the final depth of the pit. The author then listed the options of transporting by rail, truck, conveyor and inclined skip with combinations of and systems and outlined their respective merits.

69. Research so far had indicated that by establishing a crushing plant in the pit and running a conveyor from it through an underground incline to surface, a rail system could be operated economically to the prescribed future depths to form the link between the muck pile and the crusher.

70. The questions which followed the paper were on such subjects as the economic out off between open-pit and underground operations ventilation, and dust control and the driving of conveyor inclines through soft rocks.

"Methods and technology of the concentration and agglomeration of ferrous ores" (Messrs. V.A. Arsentyev and P.A. Gontarenko)

71. Magnetite was the most common commercial source of iron in the USSR, forming 65 per cent of its total reserves. Other minerals were hematite and martite. magnetite occurred in combination with quartzite and the most common method of recovery was by comminution and magnetic separation. Oxidized ores were roasted to render them magnetic and were then treated in the same way. Flotation had also been tried with successful results. For oxidized underground ores, a combination of gravity and magnetic separation was used.

72. In view of the increase in the quantities of fines, agglomeration producing both sinters and pellets was now widely used and pellets accounted for 30 per cent of all blast furnace charges.

73. The speaker then dealt with the concentration of manganese oxide and carbonate ores by the conventional methods of comminution and magnetic separation and indicated that a hydrometallurgical plant was soon to be commissioned to treat manganese elimes which formed the main losses in the present processes.

"Utilisation of room and pillar mining for uranium in the Niger" (Mr. Mahamadou Issoufou, representative of the Niger)

74. After describing the Niger's geographical position, the author explained the geological characteristics of the uranium mine itself. Lying at a depth of 250 metres, the 3 to 15 metre thick sedimentary deposit had been developed in a period of two years from two inclined shafts. The room and pillar

method of highly mechanized mining was described and it was stressed that, because of the radon hazards, the mine had to be well ventilated. He described the hydrometallurgical process used to recover yellow cake from the ore.

75. There was a lively discussion following the paper which had to be summarily closed in order to leave time for other speakers.

"Industrial blasts and the protection of structures from seismic effects" (Mr. V.V. Kuzinov and Mrs. L.P. Gribanova)

76. The speaker explained that over 100 billion cubic metres of rock were blasted in open-pits annually and much of it was in areas where residential and industrial property were located. As a result, measures had to be taken during both drilling and blasting to minimize the shock waves generated by the blasts. It was also a trend in the USSR to adopt multi-hole, high tonnage blasts at weekly intervals. In addition to assessing the characteristics of the rock to be blasted, careful attention was paid to drilling pattern, size of holes, type of explosive, means of detonation and the distribution of the explosive and stemming in the holes. Most widely used was the short delay method of initiation and the timing of sections of a single blast had been found influential in reducing the resultant shock waves.

"Development of the mining industry in Rwanda" (Mr. Jean Mburanumwe, representative of Rwanda)

77. After describing his country's geographical location, the author gave an account of the geology and exploration work that had been done. He then explained the history of mining activities in the country to show how the industry had developed. The main minerals being exploited were cassiterite, columbo-tantalite, beryl, wolframite and gold. Limestone was also to be exploited and peat was being evaluated. The mining industry was generally small-scale, operated by tributors or cooperatives. The largest mining company, SOMINRWA, was owned 49 per cent by the Government and 51 per cent by Geomines.

78. The paper generated considerable discussion amongst African participants and a great deal of interest was expressed in small-scale mining strategies and methods.

"Ventilation of highly gas-abudant extraction districts"
(Messrs. F.A. Abramov and B.I. Gretsinger)

79. With the deepening of coal mines in the Donets basin and the increase in rock pressures, the quantities of methane gas being released from the coal measure strata were also increasing. The sources of the gas were the seam itself, the broken coal and the gouf area.

80. A great deal of research had been done into improving the ventilation conditions at the working faces because of the methane gas. In particular, the paper dealt with the effects of the presence of coal mining equipment on the aerodynamic flow characteristics of the air current. By mathematical modelling, which included forecasting the turbulence of the air, it was now possible to predict accurately the probable content of methane in any face employing a certain combination of equipment. It had also been possible to improve conditions and therefore allow faces to operate at higher production capacities. The speaker showed diagrams of various ways in which working faces were ventilated.

"Leaching of uranium and copper minerals" (Mr. T.G. Carnahan, United States Bureau of Mines, Nevada)

81. Leaching of uranium and copper ores was being actively utilized in the United States to recover these minerals. Great success had been achieved in the case of the in-situ leaching of uranium because the geological conditions were almost ideal. The most common method was to pass carbonate-bicarbonate solutions down pre-drilled wells and recover the uraniferous solutions from other ones. Uranium recovery was by ion exchange.

82. In situ leaching of copper had not been as successful and most of the present activities were concentrated on dump leaching of low-grade copper ores using acidified ferric sulphate solutions which were applied as a spray to previously constituted dumps. Copper recovery was by electro-winning or by cementation using scrap iron. Investigations were proceeding on methods of in situ leaching of chalcopyrite ores.

83. The paper generated a large number of questions from both Soviet and African participants.

"The mining industry of Mali and its outlooks" (Mr. Sekou Diallo, Representative of Mali)

84. After giving a description of the geographical location of Mali, the speaker gave a historical account of the geological activities in the country and the extent to which the country had been explored. Mali's greatest problem was that of access since it was land locked and did not have well developed lines of transportation. Gold had been mined for centuries in the south and, recently, there had been attempts to revive that industry on a more systematic scale. For that purpose, the State-owned mining company, SOMAREM, had been formed. The country had however adopted an open policy as far as foreign participation was concerned and Esso, BRGM, COGEMA, AGIP and Japanese firms were actively engaged in the exploration for oil, phosphates, bauxite, iron, manganese, copper, tin, diamonds and uranium.

85. As with other papers by African delegates, the paper generated a great deal of discussion which covered the merits of foreign versus State participation in the mining industry.

"Combined storage of overburden and rejects" (Mr. M.I. Zaudalsky)

86. Great advances had been made in the treatment of low-grade iron ores but that had naturally increased the volume of tailings produced by the beneficiation plants and concentrators. In addition, the deepening of open-pits had necessitated the movement of large quantities of overburden to more remote areas where the land's capability to support cultivation had been proved to be low.

87. In the integrated mine/plant complex, consideration had been given to combining the storage of overburden and tailings in one area with the advantage that with less tailings dam construction was required and less land had to be reserved. The author then gave examples of how that could be done and suggested that one area of attention should be an increase in the solids ratio of the tailings that would be required to ensure success.

"Recent progress in mining sea-bed resources" (Mr. M.J. Cruickshank)

88. The author dealt with two aspects of mining sea-bed resources. Mining in the Exclusive Economic Zone (EEZ) and mining in the area beyond the limits of national juridiction.

89. In the former, the main advances in technology had been in the exploration and mineral processing techniques that would now be utilised. It was also noted that the mining of sand and gravel had become more significant in terms of output.

90. With regard to mining of the deep sea-bed, various consortia had been carrying out expensive research programmes on mining systems and processing designs for the recovery of minerals from manganiferous nodules. Pilot-scale tests had proved the technical and economic feasibility of such systems.

91. Lately, the most interesting progress had been made in the discovery of hydrothermal deposits containing lead, zinc, copper, silver and other minerals.

92. The paper generated a large number of questions.

"Organization and practices in geological support activities for mining industries in the USSR" (Messrs. V.M. Kazak, D.I. Betin, V.I. Batinel, L.G. Prozhogin and N.I. Derkach)

93. The paper gave a general description of the geological activities which were organized to lend support to the mining idnustry. In particular, the speaker explained how the various institutes of the USSR were organized and structured to provide service and the kinds of activities they carried out.

94. The fields in which they were engaged covered virtually every phase of mineral development from "grass roots" exploration through mineral deposit evaluation to direct assistance in the mining phase and the establishment of parameters by which mining might be monitored and ultimately controlled. Emphasis was now laid upon the use of computers to store data as well as solve complicated geological problems which might arise during the course of mining.

"Small-scale mining" (Mr. Y.I. Berejnoy)

95. The paper concentrated mainly on the mining and quarrying of industrial minerals such as marbles, clays, limestones and granites on a medium scale (under 1 million tonnes per year). The speaker presented examples of how open-pit mining was carried out using smaller pieces of equipment and what problems were faced.

"Increase in the reliability and service life of technological equipment of iron ore beneficiation plants" (Mr. V.G. Prosnitsky)

96. In the production of pellets, one of the most important factors was the efficient operation of exhaust and forced air blowers. In addition to the heat conditions under which they had to operate, they were subject to vibration, fatigue and complete mechnical failure and those conditions applied equaly to axial and centrifugal blowers.

97. Failures which occurred generally did so at the blade root and the most common reason for failure was the result of excessive vibration. As a result of the research conducted, it had been possible to analyse the effects that vibration have had on that part of the blower and incorporate design modifications which materially reduced their incidence. The speaker gave the Seminar details of those modification.

"The organization and activities of NIGRI" (Mr. A.R. Chernenko, Director of the Institute)

98. The speaker began by saying that the iron ore mining industry of Krivoy-Rog region had started 110 years ago and that since then it had passed through three stages during which different grades of ore had been exploited.

99. NIGRI had been established in 1933 and, since then, it had expanded its activities to keep pace with the services required of it by the changing industry. At the moment, its programme concentrated on the improvement of underground operations since they would form the bulk of the sources of iron ore in the future. The view of NIGRI was that mining was no longer an art but a science and the problems of the industry must be solved in a scientific manner. Also, since iron ore commanded a lower price than some other metals which were also

being mined by underground means, there was a higher priority for modern equipment to be introduced into the iron ore mines.

100. It was also NIGRI's view that insufficient attention had been paid to getting the softer rock conditions to work to advantage and that, although caving methods provided a good example, there were as yet undeveloped ways in which that property could be employed.

101. It would also be necessary to rationalize the design of underground mining equipment, at the moment there were too many varieties and it was high time to unify them, it was also the author's opinion that the use of diesel powered equipment would have to be phased out in favour of electric power.

102. The present targets for increasing productivity in the underground iron ore mines were formidable and the auther suggested that the institute should now be at the stage of planning and equipping the mines of 2000 AD to meet those targets.

103. In addition to the more conventional services supplied by the institute to the mining industry, it had large training and experimental responsibilities as well. With regard to training, it provided both professional and technical education, with regard to experimentation, it had over 400 engineers engaged in the testing of methods, systems and equipment in mines of the Krivoy-Rog regior

104. Finally, as far as the health of the workers was concerned, the institute had developed comprehensive prophylastic measures to eradicate silicosis underground as well as on the surface, where the problem was less, consisting of regular medical examinations and chest X-rays, the prevention of injurious dust accummulations in the mine and the provision of a healthy diet in canteens both underground and on the surface.

STUDY TOUR

105. Interspersed between the presentation of papers, participants were given the opportunity to visit various mines, plants and institutions related to the mining industry in the Krivoy-Rog region: a total of five days were devoted to these excursions and participants were accompanied by the USSR representatives who gave full descriptions and explanations of the facilities seen.

106. Included in the programme were:

(a) The Dzerzhinsky underground iron ore mine,
(b) The Zaporozhsky open-pit manganese mine at Ordzhonikidze and its associated land reclamation activities,
(c) The YUGOK open-pit iron ore mine,
(d) The KMZ and Artem iron ore complex,
(e) The SevGOK iron ore open-pit and beneficiation plant,
(f) The facilities of KIGRI
(g) The recreation areas of some of the above plants, and,
(h) Various other facilities related to the health and welfare of the workers

107. Participants were most impressed by all that they saw and, in particular, as far as application to the African situation was concerned, the main lessons to be learnt were the following:

(a) The necessity of providing strong technical support services to the mining industry,

(b) The benefits that could be gained from establishing a mining industry which served the needs of the surrounding community rather than being purely export-oriented.

(c) The importance of land reclamation and, in general, protection of the environment,

(d) The need for a conscious approach to the provision of facilities for the health and welfare of the population working in and supported by the mining industry.

CLOSING OF THE SEMINAR

108. The seminar concluded its deliberations on 12 June 1981. During the closing session the final report was adopted and representatives of the USSR Government, the African mining specialists and the United Nations gave their final addresses.

109. The Deputy Mayor of Krivoy-Rog congratulated the organizers and participants of the Seminar and expressed his deep satisfaction with the success of the Seminar which his city had been honoured to host. He hoped that Krivoy-Rog would in future have other opportunities of hosting similar Seminars.

110. The Director of the MIGRI Institute congratulated the African countries on their efforts in developing their mineral resources and underlined the necessity of co-operation between the USSR and Africa in such endeavours. He assured participants that the USSR was ready to assist African countries, upon request, in the development of their mineral resources.

111. The USSR Co-Director of the Seminar and Study tour on behalf of her colleagues, expressed her thanks to the secretariat of ECA for its co-operation and support in conducting the Seminar and the African specialists for their active participation and interest in the project and pointed out that all the host country representatives had tried to do everything possible to ensure the success of the project.

112. Speaking on behalf of the African specialists to the Seminar, the Director of Geology and Mines of Mali thanked the USSR Government and ECA for a Seminar and Study Tour which all the participants considered very successful.

113. He stated that the African specialists had found the Seminar and Study Tour a valuable opportunity for gaining new experience and for meeting and exchanging views among themselves and with the Soviet experts. He expressed the view of African specialists that similar events should be planned and executed in the future. He emphasized the need for increased co-operation between African countries and the developed countries to enable Africa to develop its mineral resources effectively.

114. On behalf of the United Nations the Director of the Seminar and Study Tour (PCA) and the representative of the Department of Technical Co-operation for Development (DTCD) thanked the Soviet organizers, experts and institutions whose efforts had contributed towards the success of the Seminar. Similarly, the African specialists were congratulated for their active participation in the project and assured that their views about the Seminar and Study Tour including their recommendations would be communicated to the relevant authorities within the United Nations.

TOUR CONCLUSIONS AND RECOMMENDATIONS

115. The choice of Krivoy-Rog as the venue for the Seminar and Study Tour was highly commendable considering the large mineral resources of the area and the various mineral development institutions of long standing established there.

116. The Mineral resources industries of the Krivoy-Rog Basin were found highly integrated with other sectors of the economy within the USSR and the positive effects of mineral development activity were clearly visible.

117. The considerable work put into the preparation of the project and the efforts expanded by the hosts in the provision of excellent facilities and warm hospitality facilitated greatly the smooth and efficient work of the Seminar and Study Tour.

118. Practically all the documents presented by Soviet experts dealt with large-scale mining operations and the mineral development institutions visited were similarly large-scale ones. Valuable experience was gained for large-scale mining operations in such areas as environmental protection, land reclamation the provision of social facilities to workers, and the establishment of contacts between African and USSR technicians.

119. The few papers contributed by African participants at the Seminar on small-scale mining generated enormous interest among all Seminar participants. It was highly suggested that at future seminars and study tours of a similar nature due consideration be accorded to small-scale mining operations by both African participants and host participants as such operations were considered of great importance to the majority of African countries.

120. For African countries with large mineral deposits the Krivoy-Rog basin mineral development institutions offered very appropriate training research facilities where already a sizeable community of African students existed. Accordingly, the offer of fellowships through bilateral, multilateral or other arrangements by the USSR authorities to African students concerning large-scale mining operations would be of value to African countries.

121. The working relationships between training and research institutions and mining production facilities were found to be very close. Within the African region such working relationship between multinational centres like the Eastern and Southern African Mineral Resources Development Centre, serving 19 countries of the region, would greatly promote the development of African-based indigenous capacity in mineral resources development. Hence the support of such institutions by the USSR would considerably accelerate mineral development in the African continent.

122. The large size of the mineral development institutions and facilities visited during the Seminar and Study Tour suggested that, for similar facilities to be established in many African countries, they would have to be operated as joint efforts by a number of countries because of such factors as the probable high cost of such facilities, complementarity of national resources which might occur in different countries, small markets for mineral-based products for countries with small populations, etc. Hence such mineral development facilities could act as nuclei for the promotion of co-operation by African countries in their development efforts. The support by countries like the USSR for the establishment of mineral development facilities of the Krivoy-Rog size could enhance co-operation among African countries.

123. It was the view of all African participants that the implementation of the project was very successful and that similar seminars and study tours should be encouraged and supported in the future. In particular, it was suggested that a similar seminar and study tour devoted to mineral processing should be organized. Moreover, it was recommended that another seminar and study tour should be convened within Africa for mining specialists and devoted to medium and small-scale mining.

SEMINAR AND STUDY TOUR
ON NEW MINING METHODS AND TECHNIQUES

LIST OF PAPERS

1. V.N. POLIKARPOV, full member of URSSR Academy of Sciences "Mineral resources in the Ukrainian"

2. E.O. PRILIPPENKO, Cand. Tech. Sc. (NIGRI) "Mining of Iron and manganese ore deposits"

3. V.N. POTURAEV, full member of Ukrainian Academy of Sciences "Coal mining in complicated geological conditions"

4. O.V. KOLOKOLOV, Doc. Tech. Sc. (DGI), "Experience in using pneumatic supports"

5. V.P. URVANTSEV, Cand.Tech. Sc. (NIGRI), "Mining of manganese bedded deposits"

6. S.D. MYACHIN, Cand. Tech. Sc. "Technology of underground iron ore mining"

7. G.C. KUZETS, Cand. Tech. Sc. (NIGRI) "New technology and mechanization of work when mining"

8. S.I. [illegible]MOV, Doc. Tech. Sc. "Scientific theories for creation methods for controlling the blasting energy while working the deposits by open-pit mining methods.

9. E.E. NOVIKOV, Doc. Tech. Sc. "Problems of conveyerization at the mining enterprises"

10. A.E. GAVRUTSKY, USSR, "Methods of Instrumental monitoring of shaft equipment"

11. V.V. DYDZINSKY, Cand. Tech. Sc. "Complex mechanization of preparetory and stoping operations at iron ore mines."

12. V.V. TSARIKOVSKY, Cand. Tech. Sc., "Calculation technique of parameters of structural elements of mining systems and equipment for determination their limiting state.

13. G.M. SHEVTSOVA, Eng., "Variation and differentiation method and its application in studying stress and strain condition of the rock around mine workings"

14. I.S. ZITSER, Cand. Tech. Sc. (NIGRI), "Supporting of deep underground mini

15. B.K. PLEKHANOV, Cand Tech. Sc., "Methods of determination, valuation and planning of ore mining at Krivbass mines"

16. G.A. VOROTELIAK, Cand. Tech. Sc., "Methods of breaking, parameters of drilling and blasting works and blasting means at ore underground mining"

17. F.K. ALEXEIV, Cand. Tech. Sc., "Problems of excavation of deep iron ore mines"

18. BEREGNOJ, Cand. Tech. Sc., "Methods and technology of concetration and agglomeration of ferrous ores"

19. MAHAMADOU ISSOUFOU, Director of Mines, the Niger "Use of chamber and pillar mining technique for uranium mining in the Niger"

20. L.P. GRIBANOVA, Cand. Tech. Sc., "Industrial blasts and protection of structures from seismic effects"

21. J. MBURANUMWE, Chief of Division of Mines, "Rwanda mining industrial development"

22. B.Y. GRETSINGER, Doc. Tech. Sc., "Ventilation of highly gas-abundant extraction districts of Donbass"

23. T.G. CARNAHAN, Group Supervisor, "Uranium and copper mining by leaching"

24. SEKOU DIALLO, Director-General, Mali, "Balance and perspectives of minerals prospecting in Mali"

25. M.Y. ZANDALSKY, Cand. Tech. Sc., "Combined storing of overburden and reject

26. M.I. CRUICKSHANK, Visiting Professor of Mines, United States of America "Recent progress in sea bed resources"

27. D.U. BETIN, Cand. Tech. Sc., "Organisation and practices in geological support activities for Mining industry in the USSR"

28. Y.I. BEREZNOY, Cand. Tech. Sc. "Small-scale mining"

29. V.G. PPOSVITSKY, Eng., "Increase in reliability and service life of technological equipment of iron ore benefication plants"

30. S.P. POLUYANSKY, "Development of progressive technology and techanization aids for mining in hard rocks and for ore picking"